WATER RESOURCES BOARD

INTERIM REPORT ON WATER RESOURCES IN THE NORTH

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CHAPTER 1

INTRODUCTION

1. In May 1965 the Water Resources Board were asked by the Minister of Land and Natural Resources to examine and report upon the following matters in respect of possible barrages across Morecambe Bay and Solway Firth:-

1. the feasibility and probable costs of construction;
2. the yields and qualities of water which would be made available;
3. the demand for water, and the rate of growth of that demand, in areas which might be supplied;
4. the arrangements necessary to distribute barrage water;
5. the delivered cost of treated or partially treated water;
6. other possible sources of supply in relation to the demand at 3. above and the costs of their staged development.

2. Sir Alexander Gibb and Partners and Messrs. Babtie, Shaw and Morton, Consulting Engineers, were appointed by the Board to carry out the investigations under items 1. and 2. above in respect of the Morecambe Bay and Solway Firth barrages respectively. Restrictions upon capital expenditure imposed shortly after the consultants had submitted detailed proposals made it impossible to proceed with the full-scale feasibility studies of the barrages. Instead the consultants carried out preliminary desk studies. These, together with a covering report by the Board, were published by Her Majesty's Stationery Office on 26th January 1967. On the same day the Minister of Land and Natural Resources announced in Parliament that he had asked the Board to proceed with a full feasibility study of the Morecambe Bay scheme. It was estimated that this would cost about £500,000 and would take about 3½ years. Work on this study is now in hand.

3. Investigations under items 3-6 of the terms of reference require the study of the likely demands for water up to the end of this century for the whole of that part of England north of a line from the Mersey to the Humber and of possible sources alternative to the barrages which could meet those demands. The Board therefore convened a meeting in September 1965 with the clerks and chief engineers of each of the river authorities in the North of England, namely the Northumbrian, Yorkshire Ouse and Hull, Mersey and Weaver, Lancashire and Cumberland river authorities. At this meeting it was decided to set up a Technical Working Party comprising the chief engineers of the five river authorities, representatives of the corresponding Area Committees of the British Waterworks Association, the Central Electricity Generating Board and British Waterways Board, to assess demands and resources in the area.

4. In considering the demands and resources of the North West of England the Working Party found that the position of the Liverpool Corporation water undertaking and the Wirral Water Board could not be assessed properly without reference to the overall position of the Dee and Clwyd river authority area upon which those undertakings have become so dependent. It was therefore decided to extend the study area to include the Dee and Clwyd area and to invite the river authority engineer and a representative of the B.W.A. Area Committee to join the Working Party. The complete membership of the Working Party is shown in Appendix I to this Report. The Board place on record their very real appreciation of the work of the Working Party on which this interim report is based.

5. During the preparation of this report two important measures affecting the area of study were before Parliament: the Manchester (Ullswater and Windermere) Water Order 1966 and the Tees Valley and Cleveland Water Bill*. Their purpose is to authorise schemes to meet immediate needs in south east Lancashire and on Tees-side.

6. A preliminary assessment of demands and available resources shows that in parts of the North demands on statutory water undertakings already exceed reliable resources, and after allowing for the yields of the two measures referred to in the preceding paragraph demand will overtake available resources over much of the area during the 1970's.

7. In view of this the Board thought it desirable to make an interim report giving a preliminary assessment of demands in the North up to the end of the century, together with some advance recommendations for early action to meet urgent needs. It must be emphasised that this is no more than a preliminary report. Figures given in succeeding paragraphs are mostly tentative and will certainly be revised. For example, industrial and agricultural demands have been treated cursorily in the absence of detailed information. Nevertheless the main conclusions will serve as the basis for action until the Working Party have completed their present investigations in about a year's time after which the Board hope to produce a more detailed report.

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* The Order came into operation on 6th March 1967. The Bill received the Royal Assent on 22nd March 1967.

CHAPTER 2

DEMANDS AND EXISTING RESOURCES

(1) Statutory Water Undertakings

8. There are no less than 88 statutory water undertakings supplying the area. Their limits of supply are shown on the Map accompanying this report. They vary in size from the largest supplying over 120 m.g.d. in 1965 to the small rural district council supplying only 18,000 gallons a day. The 12 largest undertakings provide 60% of the total supply.

9. The main sources of supply are upland reservoirs from which water is taken by pipeline. There is very little successive use of water by the undertakings at present, and because of the geography of the area and the concentrations of population near the coast there is only limited opportunity for such successive use.

10. In addition to supplying water for household use the undertakings supply large quantities, usually metered, to industry. These supplies are not to be confused with supplies obtained by industry from its own private sources which are referred to in paragraph 29 below.

11. The total demand on the undertakings in 1965 amounted to 857 m.g.d. Metered supplies account for 44% of this total. This compares with an average of 33% for metered supplies over the whole of England and Wales. The demand per capita was 59 gallons a day, which again is higher than the national average of 54 gallons a head. This is due to a higher demand by trade and industry. The domestic demand at 33 gallons a head is just below the national average of 34 gallons a head.

Growth of Demand

12. As in other parts of the country domestic demand must be expected to increase both from an increase in the population and from a continuing increase in use of water consequent upon rising standards of housing and the spread of water using appliances. This increase will be accompanied by an increase in demands on the statutory water undertakings by industrial users. The undertakings have supplied figures of present and future demands for both domestic and industrial supplies.

13. Experience has shown that future demands are best estimated by extrapolating previous trends in one way or another and by making allowance for planned growth e.g. Humberside. The Working Party made no attempt to impose uniformity of approach and individual undertakings adopted the method they most favoured. The choice fell almost equally between extrapolation of total demand trends and application of per capita demand trends to expected population growth. A small proportion adopted per capita demand extrapolations for domestic supplies and total demand trends for metered supplies.

TABLE A

PUBLIC WATER SUPPLY

POPULATION AND PER CAPITA DEMAND

River Authority	1965					1981				
	Ministry Estimate of Population (thousands)	Total Demand (m.g.d.)	per capita demands (g.p.d.)			Ministry Estimate of Population (thousands)	Total Demand (m.g.d.)	per capita demands (g.p.d.)		
			Metered	Domestic	Combined			Metered	Domestic	Combined
Northumbrian	2,704	175	36	29	65	2,968	293	58	41	99
Yorkshire Ouse & Hull	4,516	225	18	32	50	5,006	324	24	41	65
Dee & Clwyd	422	22	14	38	52	480	40	31	52	83
Mersey & Weaver	5,205	318	28	33	61	5,635	477	40	45	85
Lancashire	1,405	95	26	41	67	1,689	158	40	54	94
Cumberland	305	22	30	43	73	325	75	179*	52	231
Total	14,557	857	26	33	59	16,103	1,367	41	44	85

* This very high figure arises from the allowance which has been made for prospective supplies to new industries which are likely to be attracted to the West Cumberland Development Area by the availability of plentiful and cheap water.

14. The Ministry of Housing and Local Government have provided estimates of future population in each river authority area. Taking into account future migration, planned growth and natural increase, the population of the North is expected to increase by 1½ millions by 1981.

Demands and resources

15. Table A opposite shows for each river authority area estimated population and water demand in respect of public water supply for 1965 and 1981. The total estimated demand of 1367 m.g.d. in 1981 represents an average annual growth rate of 3.7% of the 1965 figure (between 1955 and 1965 the rate of growth averaged 3.3% of the 1955 figure). For comparison the estimates adopted in the Board's report on Water Supplies in South East England implied a growth rate of 3.1% between 1965 and 1981.

16. More detailed information for each statutory water undertaking is given in Appendix II which consists of a set of tables for each river authority area. Table I of each set shows for each undertaking (or the part of an undertaking in the area of that river authority) the 1965 demand and the estimated future demands in 1971, 1981 and 2001. The total demand on an undertaking extending into more than one river authority area is, of course, the sum of the parts. The figures in all cases have been calculated as average annual demands.

17. Most demands for water show some variation during the year and the demands on some undertakings (especially those serving holiday resorts) show pronounced summer peaks. They must have capacity in hand to meet those peaks although the average amount they safely supply throughout the year is much lower. In this report the resources available to an undertaking are taken to be equal to the average supply which that undertaking could provide throughout the year. Authorised resources are those for which the undertakings have all the necessary powers to abstract water, acquire land and construct works, their yield being defined as above. For simplicity in calculating future deficiencies it has been assumed that all authorised resources could be in use by 1971.

18. Transfers of water between river authority areas are shown in Tables II and III of Appendix II. For the future it has been assumed that such transfers will continue to the extent that water is available for transfer, and as between two undertakings to the limit of any authorised arrangements.

Effective deficiencies

19. The authorised net resources for each undertaking are listed under the river authority area in which they occur. The apparent balance of each undertaking is obtained by subtracting estimated future demands from authorised net resources and the resultant surpluses or deficiencies are tabulated. Since it cannot be assumed that the surpluses within a river authority area are automatically transferable to offset deficiencies elsewhere in the area, these are totalled separately. The effective deficiency in each river authority area is obtained from the sum of the individual deficiencies less the imports to the area and is shown in Table IV.

20. The effective deficiencies, disregarding any un-used surpluses, have been abstracted to Table B overleaf. This shows the amounts which have to be made available by new schemes or by the transfer of surpluses from one

TABLE B

PUBLIC WATER SUPPLY

DEMANDS AND DEFICIENCIES

River Authority	Average daily demands m.g.d.				Effective deficiencies on authorised resources - m.g.d.						
	1965	1971	1981	2001	1971	1973	1975	1977	1979	1981	2001
Northumbrian	175	232	293	417	30					82	205
Yorkshire Ouse and Hull*	225	266	334	559	21					70	284
Dee and Clwyd	22	29	40	58	4					10	26
Mersey and Weaver	318	391	477	654	33					95	266
Lancashire	95	120	158	218	8					41	98
Cumberland	22	44	75	100	4					32	56
Total	857	1,082	1,377	2,006	100	137	178	225	277	330	935

Details as at 1st April 1966

Interpolated data

* Including new Humberside conurbation

undertaking to another. In this Table provision has been made for the possible demands arising from planned development on Humberside on the grounds that supplies for such a development could not be met from sources within the Lincolnshire river authority area and may have to be met from resources in the North.

21. The effective deficiencies at particular dates (1971, 1981 etc.) are, of course, representative of a steadily growing demand. For convenience the amounts which must be available year by year have been interpolated in Table B. It must be borne in mind, however, that resources are not normally augmented each year but by the periodic development of sources. It is, therefore, usually necessary to have some supplies in hand to cover the period while a new source is being developed.

22. The effective deficiency in 1981 is considerably less than the increase in demand (1965-1981) shown in Table A. This is because the yield of authorised resources exceeded demand in 1965 by about 200 m.g.d. However, because of growth of demand over the last two years the outstanding surpluses are now only about 140 m.g.d. The extent to which these surpluses can be used to meet deficiencies elsewhere is discussed in Chapter 3 below.

23. The resources listed in Appendix II include certain sources outside the study area. The river authority areas in which those sources lie may themselves be in difficulty during the 1970's and they (or other areas e.g. Lincolnshire) may need assistance from the six river authorities in the North. For this reason, and because no separate provision is included for industrial need (see paragraph 40 below) the total effective deficiencies shown for the later 1970's in Table B should be regarded as minima.

Demand Zones

24. The area of the Northumbrian river authority at present falls into two zones. One consists of the undertakings on the Tyne and Wear which can arrange to a limited extent to share supplies. The basin of the Tees is an entirely separate zone with special problems of its own.

25. It has been assumed that in Yorkshire the industrial towns of the West Riding could exchange supplies in some instances without unduly costly new works especially since several of them are linked to the Yorkshire Derwent Scheme. The needs and conditions of Humberside pose a separate problem and the Yorkshire Ouse and Hull area figures have therefore been broken down between two zones, the rural communities of north and east Yorkshire being included with Humberside.

26. The Mersey and Weaver area is already importing water and further imports will be necessary. Its pattern of water supply divides into two parts dominated by the major undertakings of Liverpool and Manchester, with large aqueducts from North Wales and the Lake District, respectively. Bulk supplies are provided from these aqueducts to a considerable number of other undertakings. Interchange of supplies within the zones served by these aqueducts can at present be effected more readily than interchange between the two zones.

27. Cumberland (excluding the Eden Water Board area - part of which is linked with the Manchester system) forms a seventh zone, in which the most important demands are concentrated in the West Cumberland Development Area, separated from the rest of the region by the mountains of the Lake District.

28. In the light of this situation, interim problems have, therefore, been considered in terms of these seven demand zones (see Map). These zones are, however, no more than a recognition of present realities: they do not necessarily carry any implications for the larger term pattern of supply. The demands and resources in each zone are shown graphically in Figures 1-7. In these graphs, imports into the zones have been included in their available resources.

(2) Direct Industrial Demand

29. Prior to the Water Resources Act 1963 information on the consumption of water from private sources by agriculture and industry was scanty and fragmentary. Applications for licences of right under Part IV of the Act have for the first time provided basic information on the total gross abstractions from private sources. The work of verifying the authenticity of each application and granting licences has left little opportunity so far for analysis of the data that they have provided. However, from examination of the licence applications the river authorities have provided estimates of the total gross abstractions in 1965. These are set out in Table C overleaf. Some of these estimates are based upon actual abstractions in 1965 as recorded on the licence application forms, and represent the best estimate that is possible at present; others represent a summation of licensed abstractions. The licence figure is in general somewhat higher than the actual abstraction as it takes account of the capacity of the plant installed by the licensees. The figures in Table C are therefore higher than the present gross use and include some allowance for future growth.

Present net use

30. Consideration of gross use figures alone gives no indication of the overall net use of water or of the need to augment supplies as it ignores the possibility of re-use of effluents discharged back into watercourses. In this report 'net use' means the quantities that are

TABLE C

DIRECT INDUSTRIAL DEMAND

1	2	3	4	5	6	7	8	9	10
	Average Daily Demand - Millions of gallons						Increase on 1965 m.g.d.		
River Authority Area	Gross Use 1965		Net Use Including C.E.G.B.				1971	1981	2001
	Excluding C.E.G.B.	C.E.G.B.	1965	1971	1981	2001			
Northumbrian	43	-	18	22	30	44	4	12	26
Yorkshire Ouse and Hull	1,079	1,060	71(9)	104(29)	122(21)	188(35)	33	51	117
Dee and Clwyd	47	5	33(2)	39(1)	50	81(6)	6	17	48
Mersey and Weaver	930	420	104(11)	114(2)	156(7)	240(17)	10	52	136
Lancashire	172	55	22(3)	24(1)	37(6)	80(35)	2	15	58
Cumberland	40	20	37	46	61	96(6)	9	24	59
Total	2,311	1,560	285(25)	349(33)	456(34)	729(99)	64	171	444
	3,871								

NOTES: 1. Agricultural use, other than spray irrigation, excluded (see paragraph 34).

2. C.E.G.B. demands based upon C.E.G.B. estimates. The figures in brackets in Columns 4-7 are the net evaporative losses included in the net use figures listed. Reductions in these figures are accounted for by the elimination of stations with recirculatory cooling - possibly replaced by through cooling stations using estuarial or sea water - whereas increases represent the introduction of further recirculatory cooling stations.

evaporated or consumed in the manufacturing process (e.g. evaporative cooling, spray irrigation) or are lost to the catchment either by discharge of the effluent to a treatment works outside the catchment or to the sea or in some other way.

31. It follows that a realistic assessment of such net use can only be obtained by a detailed analysis of all abstractions by sub-catchment areas, with knowledge of the quantity, quality and point of return of all effluents after use, and this will take a long time to carry out. Meanwhile tentative figures of net use are shown in column 4 of Table C. It must be emphasised that these are extremely speculative. In some cases an arbitrary percentage has been applied to the total gross use by all industry. In other cases, abstractions have been summarised into broad categories to which tentative net use factors have been applied, allowance being made for effluents discharged directly to the sea or tidal estuaries.

Future net use

32. The determination of probable growth factors for net industrial use has been the subject of considerable discussion within the Working Party. Evidence from past records is almost non-existent. In one river authority area analysis of the details submitted in applications for licences indicates an annual growth over the past five years of about 2%. Consideration of the growth of metered supplies to trade and industry from the public water supply may be thought to give some indication of probable industrial growth. Even here it must be pointed out that the figures relate to gross and not net use and may be further obscured by a transfer of demands from the public to the private sector or vice versa. In the data submitted by the statutory water undertakings the average growth rate forecast from past records for metered consumption is 4.5%. This compares with the average for the whole country over the last ten years of 2.6%.

33. In arriving at the future net use figures in Table C an annual growth of 4% of the 1965 net figure has been assumed. However, further study will have to take into account the possible effects of water costs on this growth rate in areas where local supplies may have to be supplemented with more costly imports.

(3) Agricultural Demand

34. Agricultural demand falls into two general classes: spray irrigation and general use. No substantial increase is to be expected in general use and on the assumption that it will continue to be met from public water supply, or from small local sources, and will have very little impact on future conservation schemes, no further separate consideration has been given to it.

35. The existing spray irrigation demand has been calculated from applications for licences of right, and has been compared with figures provided by the Ministry of Agriculture, Fisheries and Food from their spray irrigation census. The census has also been used to project probable growth within the ceiling of potential irrigation development. Over the area as a whole spray irrigation demands are small in relation to the total direct demand on the rivers, although local difficulties might well arise. Where spray irrigation demand is significant, provision has been made in the Industrial Demand Table for future irrigation requirements in terms of the equivalent daily use in a year of peak demand.

(4) C.E.G.B. Demand

36. The Central Electricity Generating Board estimate that by the early 1980's the demand for power in the area will be only slightly less than that for the whole of England and Wales today and that new plant will have to be installed to the extent of about one half of that now in operation in England and Wales.

37. Planning and amenity problems in routing transmission lines are likely to result in power stations being sited close to centres of demand and, especially in areas remote from the low-cost coalfields, more of these will be nuclear stations. It is to be expected, therefore, that most of the demand which is forecast for the study area will be met by plant sited in that area. Nuclear stations will probably be sited on the coast and estuaries, but it is prudent to bear in mind the possibility that any future oil or coal fired plant may be sited inland.

38. The Generating Board's approximate present use of non-saline cooling water and estimates of the demand in 1971 and 1981 are shown with other direct industrial demand in Table C. The Board have indicated that the forecasts for 1971 only are firm estimates based upon approved plans. They emphasise that forecasts of cooling water demands, or even of the methods of power generation in 1981, ten years beyond the date for which they have firm plans, must be speculative in the extreme. Where they have indicated a range in the 1981 forecasts the mean value of the range has been adopted in this report.

(5) Total Demands for industry, agriculture and C.E.G.B.

39. The total gross and net use by industry, agriculture and the Generating Board in 1965 and estimates for 1971, 1981 and 2001 are summarised in Table C. The net increases over the 1965 figure (columns 8, 9 and 10) cannot be reckoned as deficiencies except where it is known that present abstractions are utilising all the available resources, and that no further abstractions can be permitted without conservation works. In some areas this may be true; indeed, resources may prove inadequate in a dry year. In others it is obviously not, and a true assessment of deficiencies cannot be made until the sub-catchment analyses referred to in paragraph 31 above have been completed to determine the true net use, and available resources have been established having regard to quality requirements and the determination of minimum acceptable flows in the inland waters concerned. Consideration has also to be given to the effect of the increasing quantities of sewage effluent that may be discharged as a result of the increasing quantities of water which it is estimated will have to be provided through the public supply. A more reliable assessment is necessary of probable overall deficiencies than has been possible from the superficial examination so far made. The Working Party will be giving attention to this.

40. At this stage the real industrial deficiency cannot be established sufficiently clearly either in quantity or location to justify consideration of measures specifically to increase industrial supplies. In Chapter 3 developments are indicated which could more than meet the growth in demand on the statutory water undertakings over the next decade and for the time being it is assumed that any immediate industrial demands will be met by those developments.

CHAPTER 3

NEW RESOURCES

Schedule of potential resources

41. A schedule of potential resources is being drawn up by the Working Party for each of the six river authority areas. This will not be as complete as the statutory surveys which will be made in due course by each river authority under section 14 of the 1963 Act, and estimates of yield and cost will remain somewhat speculative until schemes have been investigated on the ground. Nevertheless the Board hope to present in a later, more detailed, report as comprehensive a picture as possible of the resources which could be developed in the study area and to outline possible lines of development to the end of the century. In assessing these the Board will give full consideration to all uses and to all interests, including agriculture, the preservation of natural beauty and outdoor recreation.

42. The schedule will list individual schemes which have been contemplated by statutory water undertakings for new abstractions and/or storage or for better use of existing storage. In addition it will include an assessment of the net overall addition to resources which can be made by exploiting existing or new storage for the general benefit of each river basin (e.g. by river regulation) and, where appropriate, by the regional use of storage for the benefit of several river basins.

43. The use of water in underground strata in conjunction with sources of supply on the surface, so that underground storage is developed and exploited to augment river flows, will also be considered where such possibilities exist.

44. The role of barrages will be considered insofar as information is available from the desk and feasibility studies.

Interim proposals

45. Until the various resources have been fully assessed and compared it is not possible to put forward comprehensive proposals for the development of resources over the whole area to the end of the century. Demands will, however, overtake available resources over much of the area during the 1970's. It is the purpose of the remainder of this report to indicate schemes capable of development in time to meet those demands without, as far as can be foreseen, prejudicing any subsequent long-term development programme whether of inland or barrage schemes.

46. In paragraph 22 it was mentioned that at the present time (1967) the yield of authorised resources exceeds demands over the whole study area by about 140 m.g.d. It is convenient at this stage to consider how this surplus could be deployed within the seven demand zones described in paragraphs 24-27 above in which advantage might be taken of existing or potential facilities for interchange of supplies. This is done in paragraphs 47-63 below. The conclusion reached is that about 40 m.g.d. would be transferred to meet deficiencies arising by 1971. Any transfers would have to

be authorised under the Water Act 1945 and in certain cases new links would be required. In general such links would be useful steps towards a wider regional distribution system and the transfer would afford time to work out and initiate a comprehensive development programme. The relationship between resources and demands in each of the demand zones is shown in Figures 1-7 on the assumption that such transfers will be effected. To the extent that these transfers are not effected the position will be worse than the Figures show it.

Northumbria: North and South Zones

47. The north zone comprises the Tyne and Wear catchments and areas further north; the south zone comprises the Tees catchment, where the water situation has been dominated by a rapid growth of industrial use on Tees-side.

Expected deficiencies are:-

	m. g. d.	
	1971	*1981*
North Zone	-	29
South Zone	24	53

48. Changes in the use made of the Derwent reservoir combined with abstraction from the river Wear seem likely to provide at least 10 m.g.d. for the Sunderland area and 9 m.g.d. may be obtainable by further abstraction from the river North Tyne balanced against existing storage capacity of the Newcastle and Gateshead Water Company. A little more ground-water may also be obtainable in the Hartlepools area.

49. The Cow Green Reservoir scheme will provide 35 m.g.d. and thus meet the very urgent needs of Tees-side. Even so Figure 2 shows that a further supply is likely to be required there from 1974, although this date may be extended by a few years by improved regulation techniques based on operating experience and by local ground-water development.

50. By the later 1970's further supplies are likely to be needed throughout Northumbria. The provision of these will inevitably involve new storage somewhere. There are possible reservoir sites on the following rivers: the Wear, the North Tyne, the Coquet and the Tees. There are also sites in Cumberland from which water could be fed into the South Tyne. As yet there is insufficient information to compare these sites. At a later date tidal areas on the west coast might be used. However, it would be wrong to suppose that any storage proposal will escape strong objections by one interest or another.

51. In these developments a north-south aqueduct linking the principal rivers of the area seems likely to play an important part by enabling storage at any of these sites to benefit the whole area. After completion of the Cow Green reservoir there will be a very considerable storage on the river Tees and by enabling this storage to be operated in conjunction with almost the entire river flows of Northumbria such an aqueduct would immediately augment in some measure the water resources available for use. The planning of such an aqueduct, perhaps for development in stages, therefore deserves the early attention of the Northumbrian river authority.

North and East Yorkshire and West Riding Industrial Zones

52. In the rural areas of north Yorkshire it may be assumed that distributable surpluses and new local sources will balance deficiencies. The remaining surpluses in these areas are not, however, suitably placed for transfer to the rest of the North and East Yorkshire Zone and the following deficiencies will therefore remain:-

	m.g.d.	
	1971	*1981*
North and East Yorkshire Zone (effectively Hull and Humberside)	2	17*

* Includes 10 m.g.d. for new Humberside development

53. In the West Riding Industrial Zone a substantial proportion of the 1971 deficiencies could probably be met by transfer of surpluses. If it is assumed that virtually all surpluses in the zone are transferable to other undertakings by 1971 the outstanding deficiencies will be as follows:-

	m.g.d.	
	1971	*1981*
West Riding Industrial Zone	4	48

Further development of resources in the northern part of this zone should be capable of meeting the balance of the 1971 deficiency and some of the growing demands in that part of the zone thereafter. In 1981 a deficiency of up to 20 m.g.d. would remain, predominantly in Sheffield and areas nearby.

54. Thus in the two zones together there will be a small deficiency of 2 m.g.d. to 6 m.g.d. in 1971 and this will increase to about 37 m.g.d. by 1981. It is also likely that demands during the 1970's in northern Lincolnshire i.e. in addition to those arising from planned growth on Humberside, will have to be met from resources in Yorkshire. These demands might reach about 20 m.g.d. by 1981 making a total deficiency of nearly 60 m.g.d. Early action is essential to meet the deficiencies in the early 1970's and work should proceed immediately on a regulating reservoir at Farndale on the Yorkshire Derwent. Such a reservoir could provide an additional 25 m.g.d. at Elvington and enable a further abstraction to be made above a weir at the tidal limit of the river which would help meet the Hull and Humberside and Lincolnshire needs. Powers for the construction of a direct supply reservoir at Farndale were conferred on Hull Corporation by the Kingston upon Hull Corporation Act 1933, and the Corporation own the land that would be inundated. In 1952 the area was included in the North York Moors National Park.

Dee Zone

55. The undertakings in this zone include Liverpool Corporation and neighbouring areas in Lancashire and Cheshire which depend in some measure on the resources of the Dee and Clwyd river authority area. Authorised abstractions from the river Dee (regulated by Llyn Tegid and Llyn Celyn) should suffice to meet the growth in demand in this zone until about 1974:-

	m.g.d. 1971	m.g.d. 1981
Dee Zone	Surplus 18	Deficiency 40

56. It seems likely that development of local sources - notably ground-water and a regulating reservoir in the river Clwyd for the benefit of consumers in Flintshire and Denbighshire - and an increase in the yield of existing sources on the river Dee will meet demands almost until 1981. The further possibilities for this zone (apart from barrage supplies) include additional regulating storage on the river Dee and import of water from North Lancashire, or both.

West Pennine Zone

57. This zone includes the Manchester Corporation undertaking and a number of undertakings which are entitled to bulk supplies from Manchester together with the remaining undertakings west of the Pennines that do not fall into the Cumberland or Dee Zones. It is estimated that the following additional amounts will be needed for this zone:-

	m.g.d. 1971	m.g.d. 1981
West Pennine Zone	18	93

58. The Manchester (Ullswater and Windermere) Water Order 1966 provides for the abstraction of water from Ullswater and Windermere to augment the reliable yield of Manchester's sources by something over 40 m.g.d. This major addition to the resources of the zone is urgently required to overtake a shortfall in reliable yield which already threatens supplies in the areas of many of the undertakings concerned. It will be seen from Figure 6 that after allowing for the Order demands in the zone are likely to overtake its augmented resources once again by about 1975. Provision should therefore be made for a further major resource to come into operation not later than 1975 and construction work on this should start by 1971. A scheme providing about 50 m.g.d. is needed to meet demands until works provided under the long term pattern of supply become operational. Such a scheme might also help the Dee Zone towards the end of the decade.

59. A reservoir in the Lune catchment appears likely to meet the need economically and to provide water of a quality not greatly inferior to that of the traditional Lake District supply. Within that catchment schemes for impounding Borrowbeck and for pumped storage at Killington would apparently meet requirements. Investigation and economic comparison of these two schemes is likely to be recommended in the final report of the Working Party.

Cumberland Zone

60. This zone includes the areas of the three undertakings on the west coast of Cumberland - Carlisle and the West and South Cumberland Water Boards - together with those of two small undertakings at Keswick and Millom. These areas do not fit readily into a pattern of regional development in view of

their geographical isolation. The significant deficiencies are in the areas of the South and West Cumberland Water Boards, and are as follows:-

m.g.d.	
1971	1981
7	36

These deficiencies consist largely of estimated increased demand from existing industry and the expected demands of new industry.

61. The 1971 deficiency (which is in the area of the South Cumberland Water Board) may be met by development of ground-water in the St. Bee's Sandstone and this possibility should be explored without delay.

62. The Cumberland river authority have appointed consulting engineers to investigate the possibility of developing pumped storage reservoirs outside the Lake District National Park to be operated in conjunction with a tidal weir across the mouth of the river Derwent. Several sites are under consideration; these schemes may help to meet deficiencies after 1971.

63. A proposal has been made to develop the yield of the rivers Calder and Bleng by means of a reservoir on the river Calder just inside the National Park. This scheme should be investigated. Some investigations have been made already of a reservoir on the Upper Caldew also in the National Park. Various other schemes for storage within the National Park have been put forward, some of which would make limited use of certain of the lakes near the western perimeter. Strong opposition may be expected to some of these schemes. It should, however, be possible to meet the estimated demands to 1981 without severe encroachment on the National Park. Thereafter major schemes may have to be developed in the Park unless water is to be imported from elsewhere. This alternative would increase the price of water in the West Cumberland Development Area and might appreciably reduce the attractions of that area to certain industries.

CHAPTER 4

SUMMARY

64. (1) As part of their feasibility studies of barrages across Morecambe Bay and Solway Firth the Board set up a Technical Working Party to estimate the demand for water in the North to the end of this century and the possible sources of supply, other than estuarial barrages, which could meet those demands.

(2) The Working Party have almost completed their work on estimating future demands for the public water supply. Work is in hand on industrial and agricultural demands for which detailed information only recently became available under Part IV of the Water Resources Act 1963. The Working Party are also turning their attention to possible resources to meet demands and hope to complete a report in about a year's time.

(3) The purpose of this interim report by the Board is to give a preliminary assessment of the position in the North together with some recommendations for early action to meet urgent needs.

(4) In parts of the North the demands on statutory water undertakings already exceed the reliable yields of resources. Over the whole area additional supplies amounting to about 100 m.g.d. and about 330 m.g.d. are likely to be required by 1971 and 1981 respectively. Even after allowing for the Manchester (Ullswater and Windermere) Water Order 1966 and the Tees Valley and Cleveland Bill (see paragraph 5 above) demands will overtake available resources over much of the area during the 1970's.

(5) The interim situation can best be considered in terms of seven demand zones (see Map) in which advantage might be taken of existing or potential facilities for interchange of supplies. Indeed in describing the additional works which must be provided by 1971 for the public supply it has been assumed that such transfers will be effected. Without them the deficiency in 1971 would be appreciably higher. The situation in the seven demand zones on this basis is shown graphically in Figures 1-7. It must be stressed that these zones are no more than a recognition of present realities and do not necessarily carry any implications for the longer term pattern of supply.

(6) At this stage future industrial demands on private sources of supply cannot be established sufficiently clearly either in quantity or location to justify consideration of measures specifically to increase such supplies. Nevertheless these demands are likely to increase. After taking into account the additional requirements of the Central Electricity Generating Board and of spray irrigators increases of about 64 m.g.d. and 171 m.g.d. in 1971 and 1981 respectively have been estimated. For the time being it is assumed that any immediate industrial demands will be met by the developments which must be carried out to meet the growth in demand on statutory water undertakings.

(7) An immediate start should be made on the following:-

(a) the Ullswater and Windermere scheme;

(b) the Cow Green reservoir;

(c) a regulating reservoir in Farndale on the Yorkshire Derwent;

(d) investigations into ground-water and surface schemes in west Cumberland.

Early attention should also be given to the planning of a north-south aqueduct linking the principal rivers in the area of the Northumbrian river authority.

(8) By themselves those schemes will not suffice to safeguard supplies during the 1970's. Other sources of supply will have to be brought into operation by the middle years of that decade. It should be possible to find such sources without, as far as can be foreseen, prejudicing any subsequent long-term development programme whether of inland or barrage schemes. Full consideration will, of course, be given to other interests including agriculture, the preservation of natural beauty and outdoor recreation.

(9) More detailed information will be given in a further report in about a year's time. Final decisions about the longer term pattern of development will, however, have to await the outcome of the investigations of the physical feasibility of a Morecambe Bay barrage scheme and an overall assessment of that scheme.

Reading Bridge House,
Reading,
Berks.

14th March 1967

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APPENDIX I

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Deputies for Members

The undermentioned sat from time to time on the Working Party as deputies:

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NORTHUMBRIAN RIVER AUTHORITY
PUBLIC WATER SUPPLY
TABLE I

Ref. No.	Undertaking	Average daily demands - m.g.				Resources m.g.d.					Apparent Overall Deficiencies (-) or Surpluses (+) on Net Resources - m.g.d.					
		1965	1971	1981	2001	1965	Authorised	Bulk Supplies		Net Authorised	1971		1981		2001	
								+	-		+	-	+	-	+	-
	Darlington C.B.C.	6.2	7.7	9.5	11.0	7.0	7.0	-	-	7.0	-	0.7	-	2.5	-	4.0
	Durham Co. W.B.	15.8	19.1	23.6	31.0	14.0	24.3	0.1	-	24.4	5.3	-	0.8	-	-	6.6
	Eden W.B. (5)	0.1	0.1	0.1	0.1	0.2	0.2	-	-	0.2	0.1	-	0.1	-	0.1	-
	Hartlepools W.Co.	10.8	14.0	16.0	18.6	11.0	11.0(2)	-	-	11.0	-	3.0	-	5.0	-	7.6
	Newcastle & Gateshead W.Co.	41.2	48.2	61.6	94.8	44.0	47.0	5.9(1)	-	52.9	4.7	-	-	8.7	-	41.9
	Sunderland & South Shields W.Co.	23.5	31.0	40.4	54.2	16.7	29.1	-	0.1	29.0	-	2.0	-	11.4	-	25.2
	Tees Valley & Cleveland W.B.	68.0	99.9	126.6	186.2	76.2	76.2	-	-	76.2	-	23.7	-	50.4	-	110.0
	Tynemouth C.B.C.	9.3	11.5	14.7	20.7	6.6	6.8	4.1(1)	-	10.9	-	0.6	-	3.8	-	9.8
	Totals m.g.d.	174.9	231.5	292.5	416.6	175.7	201.6	10.1	0.1	211.6	10.1	30.0	0.9	81.8	0.1	205.1

Notes:
(1) Bulk supplies from Coquet Water Board
(2) Excluding yield of new underground sources, 4.0 m.g.d. - test drilling in hand
(3) Croft and Darlington R.D.C.'s omitted as demands and resources less than 0.1 m.g.d.
(4) Fringe area Stokesley no details available
(5) Eden W.B. appears also in the Cumberland River Authority Table I

Table II - IMPORTS - NIL

Table III - EXPORTS - NIL

Table IV - NET DEFICIENCIES

	1971	1981	2001
Effective deficiency to nearest 5 m.g.d.	30	80	205

APPENDIX II

YORKSHIRE OUSE & HULL RIVER AUTHORITY

PUBLIC WATER SUPPLY

TABLE I

Ref. No.	Undertaking	Average daily demands m.g.				Resources m.g.d.					Apparent Overall Deficiencies (-) or Surpluses (+) on Net Resources - m.g.d.					
		1965	1971	1981	2001	1965	Authorised	(1)Bulk Supplies +	-	Net Authorised	1971 +	-	1981 +	-	2001 +	-
	Barnsley C.B.C.	6.6	8.2	10.8	16.0	7.6	8.9	-	-	8.9	0.7	-	-	1.9	-	7.1
	Bingley U.D.C.	0.8	0.9	1.1	1.3	0.2	0.2	0.4	-	0.6	-	0.3	-	0.5	-	0.7
	Bradford C.B.C.	19.1	22.4	26.6	34.6	18.5	23.5	-	5.3	18.2	-	4.2	-	8.4	-	16.4
	Calderdale W.B.	9.0	10.4	12.9	18.0	10.6	10.6	0.2	1.6	9.2	-	1.2	-	3.7	-	8.8
	Claro W.B.	6.2	7.0	8.2	10.4	8.7	10.3	-	-	10.3	3.3	-	2.1	-	-	0.1
	Craven W.B. (7)	4.7	5.2	6.2	8.0	4.1	4.9	-	-	4.9	-	0.3	-	1.3	-	3.1
	Doncaster & District Joint W.B. (8)	7.4	8.1	10.0	13.7	0.3	0.3	1.0	-	1.3	-	6.8	-	8.7	-	12.4
	East Yorks W.B.	5.3	6.6	8.9	15.0	7.6	9.3	0.2	-	9.5	2.9	-	0.6	-	-	5.5
	Huddersfield C.B.C.	11.2	12.2	14.2	18.9	10.2	15.5	-	-	15.5	3.3	-	1.3	-	-	3.4
	Kingston-upon-Hull C.B.C. (2)	21.9	29.0	34.0	44.0	26.8	26.8	-	0.1	26.7	-	2.3	-	7.3	-	17.3
	Leeds C.B.C.	27.6	30.7	36.4	47.6	30.6	36.2	-	0.2	36.0	5.3	-	-	0.4	-	11.6
	Mid Calder W.B.	6.7	7.5	8.4	10.1	4.7	4.7	1.9	-	6.6	-	0.9	-	1.8	-	3.5
	Northallerton & The Dales W.B.	2.9	3.4	3.8	5.0	2.7	2.7	-	-	2.7	-	0.7	-	1.1	-	2.3
	Norton U.D.C.	0.3	0.4	0.4	0.6	1.0	1.0	-	-	1.0	0.6	-	0.6	-	0.4	-
	N. Derbyshire W.B. (9)	10.2	14.2	19.5	39.5	3.6	3.6	-	-	3.6	-	10.6	-	15.9	-	35.9
	Oldham C.B.C. (10)	-	-	-	-	1.6	1.6	-	-	1.6	1.6	-	1.6	-	1.6	-
	Pontefract, Goole & Selby W.B.	5.7	8.3	10.7	15.6	6.6	6.6	0.2	0.1	6.7	-	1.6	-	4.0	-	8.9
	Pudsey M.B.	1.4	1.8	2.3	2.8	-	-	1.4	-	1.4	-	0.4	-	0.9	-	1.4
	Rawmarsh U.D.C.	0.8	0.8	0.9	0.9	-	-	0.8	-	0.8	-	-	-	0.1	-	0.1
	Rochdale C.B.C. (10)	-	-	-	-	1.7	1.7	-	-	1.7	1.7	-	1.7	-	1.7	-
	Rombalds W.B.	4.6	5.2	6.8	10.9	3.6	5.6	0.3	-	5.9	0.7	-	-	0.9	-	5.0
	Rotherham C.B.C.	4.7	4.9	5.8	7.2	0.7	0.7	5.3(3)	0.8	5.2	0.3	-	-	0.6	-	2.0
	Ryedale J.W.B.	3.9	5.0	7.0	10.0	3.9	4.3	-	-	4.3	-	0.7	-	2.7	-	5.7
	Scarborough M.C.	4.2	5.8	6.8	10.8	8.4	10.2	-	-	10.2	4.4	-	3.4	-	-	0.6
	Sheffield C.B.C.	37.0	41.7	50.8	74.3	31.4	37.9	0.5(5)	6.3(3)	32.1	-	9.6	-	18.7	-	42.2
	Spenborough M.C.	1.2	1.4	1.5	1.6	-	-	1.2	-	1.2	-	0.2	-	0.3	-	0.4
	Wakefield & District W.B.	11.9	14.7	18.2	27.0	9.4	9.4	1.5	-	10.9	-	3.8	-	7.3	-	16.1
	Wortley R.D.C.	0.2	0.2	0.3	0.4	0.2	0.2	-	-	0.2	-	-	-	0.1	-	0.2
	York W.W. Co. (4)	9.2	10.4	11.9	15.0	16.4	16.4	-	-	16.4	6.0	-	4.5	-	1.4	-
	Totals m.g.d.	224.7	266.4	324.4	459.2	221.1	253.1	14.9	14.4	253.6	30.8	43.6	15.8	86.6	5.1	210.7

NOTES:
(1) Assuming existing bulk supply obligations or transfers will continue.
(2) Resources exclude the Farndale Reservoir scheme.
(3) Including Rotherham's entitlement in Yorkshire Derwent Stage II as a bulk supply from Sheffield.
(4) Including the whole of Flaxton R.D.C.
(5) Net Gain of 0.5 m.g.d. from N.C.B.
(6) Fringe areas; Stokesley no details available, Central Nottinghamshire W.B. demands within the area insignificant.
(7) Craven W.B. appears also in the Lancashire River Authority Table I.
(8) Doncaster & District Joint W.B. figures exclude that part of the Water Board in the Trent River Authority area.
(9) North Derbyshire W.B. appears also in the Mersey & Weaver River Authority Table I. Figures exclude that part of the Water Board in the Trent River Authority area.
(10) Oldham C.B.C. and Rochdale C.B.C. appear also in the Mersey & Weaver River Authority Table 1.

TABLE II - IMPORTS

	Average daily transfers m.g.d.		
	1971	1981	2001
Doncaster & District W.B. transfer from Trent	6.8	8.0	8.0
North Derbyshire W.B. do.	5.7	5.7	5.7
Sheffield C.B.C. do.	13.1	13.1	13.1
Totals - m.g.d.	25.6	26.8	26.8

TABLE III - EXPORTS

	Average daily transfers		
	1971	1981	2001
Oldham C.B.C. transfer to Mersey & Weaver	1.6	1.6	1.6
Rochdale C.B.C. do.	1.7	1.7	1.7
Totals - m.g.d.	3.3	3.3	3.3

TABLE IV - EFFECTIVE DEFICIENCIES

	1971	1981	2001
Effective deficiencies by deduction of imports from deficiencies in Table I - to nearest 5 m.g.d.	20	60	185

DEE AND CLWYD RIVER AUTHORITY

PUBLIC WATER SUPPLY

TABLE I

Ref. No.	Undertaking	Average daily demands m.g.				Resources m.g.d.					Apparent Overall Deficiencies (-) or Surpluses (+) on Net Resources - m.g.d.					
		1965	1971	1981	2001	1965	Authorised	(1)Bulk Supplies +	-	Net Authorised	1971 +	-	1981 +	-	2001 +	-
	Ceiriog R.D.C. (5)	0.3	0.7	0.9	1.3	0.2	0.2	-	-	0.2	-	0.5	-	0.7	-	1.1
	Central Flintshire W.B.	3.7	5.8	10.6	13.5	0.4	0.4	2.5	-	2.9	-	2.9	-	7.7	-	10.6
	Chester W.W.Co.	4.2	5.6	6.9	9.4	7.5	7.5	-	0.1	7.4	1.8	-	0.5	-	-	2.0
	East Shropshire Water Board (5)	0.3	0.5	0.6	0.8	0.8	0.8	-	-	0.8	0.3	-	0.2	-	-	-
	Liverpool C.B.C. (6)	-	-	-	-	32.0	64.0	-	-	64.0	64.0	-	64.0	-	64.0	-
	Maelor R.D.C. (5)	0.2	0.2	0.2	0.2	-	-	-	-	-	-	0.2	-	0.2	-	0.2
	Merioneth W.B. (5)	0.2	0.2	0.3	0.5	0.3	0.3	-	-	0.3	0.1	-	-	-	-	0.2
	Mid Cheshire W.B. (6)	0.4	0.5	0.7	1.2	8.0	8.0	-	-	8.0	7.5	-	7.3	-	6.8	-
	West Denbighshire & West Flintshire W.B. (5)	4.8	5.5	6.5	10.1	5.1	5.1	0.4	-	5.5	-	-	-	1.0	-	4.6
	Wirral W.B. (6)	1.6	1.9	2.1	3.1	33.7	33.7	-	5.5(3)	27.6(4)	25.7	-	25.5	-	24.5	-
	Wrexham & East Denbighshire W.Co.	5.8	8.3	10.8	17.4	10.4	10 4	-	0.1	10.3	2.0	-	-	0.5	-	7.1
	Totals	21.5	29.2	39.6	57.5	98.4	130.4	2.9	5.7	127.0	101.4	3.6	97.5	10.1	95.3	25.8

NOTES:
(1) Assumes existing obligations or transfers will continue.
(2) West Shropshire W.B. omitted, demands insignificant and assumed met from existing sources.
(3) Includes non potable supply of 2.0 m.g.d. to John Summers and 0.8 m.g.d. potable supplies to industry off the Alwen aqueduct.
(4) Allowing reduction of 0.6 m.g.d. for ultimate abandonment of unsatisfactory borehole sources.
(5) Ceiriog R.D.C., East Shropshire W.B., Maelor R.D.C., Merioneth W.B. and West Denbighshire & West Flintshire W.B. - The areas of supply of these undertakings extend beyond the boundary of the study. The figures include only those parts of their areas within the Dee and Clwyd River Authority area.
(6) Liverpool C.B.C., Mid Cheshire W.B. and Wirral W.B. appear also in the Mersey & Weaver River Authority Table I.

APPENDIX II

TABLE II - IMPORTS

	Average daily transfers m.g.d.		
	1971	1981	2001
Liverpool C.B.C. transfer from Severn to Maelor R.D.C.	0.2	0.2	0.2

TABLE III - EXPORTS

	1971	1981	2001
Liverpool C.B.C. transfer to Mersey and Weaver	36.4	55.9	64.0
Mid Cheshire Water Board transfer to Mersey and Weaver	7.2	7.3	6.8
Wirral Water Board transfer to Mersey and Weaver	25.7	25.5	24.5
Totals - m.g.d.	69.3	88.7	95.3

TABLE IV - EFFECTIVE DEFICIENCIES

	1971	1981	2001
Effective deficiencies by deduction of imports from deficiencies in Table I - to nearest 5 m.g.d.	5.0	10.0	25.0

MERSEY AND WEAVER RIVER AUTHORITY

PUBLIC WATER SUPPLY

TABLE I

Ref. No.	Undertaking	Average daily demands m.g.				Resources m.g.d.					Apparent Overall Deficiencies (-) or Surpluses (+) on Net Resources - m.g.d.					
		1965	1971	1981	2001	1965	Autho-rised	(1)Bulk Supplies		Net Authorised	1971		1981		2001	
								+	-		+	-	+	-	+	-
	Ashton-under-Lyne etc. W.J.Ctee	6.5	7.8	9.8	12.4	6.9	6.9	-	-	6.9	-	0.9	-	2.9	-	5.5
	Bolton C.B.C.	22.7	27.0	31.7	43.1	17.1	17.1	7.4	-	24.5	-	2.5	-	7.2	-	18.6
	Chester W.W.Co. (6)	0.2	0.3	0.4	0.5	0.5	0.5	-	-	0.5	0.2	-	0.1	-	-	-
	Heywood & Middleton W.B.	4.2	5.3	6.3	9.4	5.4	5.4	0.1	-	5.5	0.2	-	-	0.8	-	3.9
	Liverpool C.B.C. (7)	63.9	75.0	94.0	130.0	3.0	3.0	0.1	11.9	8.8	-	83.8	-	102.8	-	138.8
	Macclesfield Dist. W.B.	4.4	5.2	6.7	9.7	5.1	0.7	0.7	-	5.8	0.6	-	-	0.9	-	3.9
	Makerfield W.B. (8)	6.3	8.1	10.0	15.3	6.0	7.0	-	-	7.0	-	1.1	-	3.0	-	8.3
	Manchester C.B.C. (9)	95.4	113.0	134.0	176.0	24.0	24.0	-	11.6	12.4	-	100.6	-	121.6	-	163.6
	Mid Cheshire W.B. (6)	11.6	14.6	20.0	35.0	6.0	6.0	0.5	-	6.5	-	8.1	-	13.5	-	28.5
				(35)	(60)(2)											
	North Derbyshire W.B. (10)	0.6	0.7	0.9	1.9	0.7	0.7	-	-	0.7	-	-	-	0.2	-	1.2
	Oldham C.B.C. (10)	10.5	11.5	13.2	15.4	8.9	9.9	-	-	9.9	-	1.6	-	3.3	-	5.5
	Rochdale C.B.C. (10)	6.4	7.3	8.6	13.6	4.5	5.3	-	0.1	5.2	-	2.1	-	3.4	-	8.4
	Runcorn Dist. W.B.	3.1	7.3	9.3	10.5	-	-	6.0	-	6.0	-	1.3	-	3.3	-	4.5
	Staffs. Potteries W.B.	0.8	1.0	1.3	1.9	1.5	1.5	-	-	1.5	0.5	-	0.2	-	-	0.4
	St. Helens C.B.C.	9.5	11.2	13.2	17.1	5.5	5.5	4.4	0.1	9.8	-	1.4	-	3.4	-	7.3
	Stockport & Dist., W.B.	14.7	17.7	22.0	26.2	12.3	15.0	4.1	0.7	18.4	0.7	-	-	3.6	-	7.8
	Warrington C.B.C.	18.4	23.0	30.0	44.0	18.1	18.1	1.1	-	19.2	-	3.8	-	10.8	-	24.8
	West Lancs. W.B. (8)	2.2	3.2	3.9	4.7	5.1	5.1	-	-	5.1	1.9	-	1.2	-	0.4	-
	Widnes M.C.	9.7	13.1	17.0	23.0	14.0	14.0	2.0	0.5	15.5	2.4	-	-	1.5	-	7.5
	Wirral W.B. (6)	26.8	38.8	44.6	63.9	9.1	9.1	-	-	5.7(4)	-	33.1	-	38.9	-	58.2
	Totals	317.9	391.1	476.9	653.6	153.7	159.2	26.4(3)	24.9	157.3	6.5	240.3	1.5	321.1	0.4	496.7

NOTES:
(1) Assumes existing obligations or transfers will continue.
(2) Additional requirements if new town built in South Cheshire.
(3) Net gain by St. Helens of 1.0 m.g.d. from B.W.B.; 0.5 m.g.d. from N.C.B.
(4) Allowing reduction of 3.4 m.g.d. for ultimate abandonment of unsatisfactory borehole sources.
(5) East Shropshire W.B. and Leek R.D.C. omitted, as demands within the river authority area are insignificant.
(6) Chester W.W.Co., Mid Cheshire W.B. and Wirral W.B. appear also in the Dee and Clwyd River Authority Table I
(7) Liverpool C.B.C. appears also in the Dee and Clwyd and Lancashire River Authorities Tables I.
(8) Makerfield W.B. and West Lancs. W.B. appear also in the Lancashire River Authority Table I.
(9) Manchester C.B.C. appears also in the Lancashire and Cumberland River Authorities Tables I.
(10) North Derbyshire W.B., Oldham C.B.C. and Rochdale C.B.C. appear also in the Yorkshire Ouse and Hull River Authority Table I.

TABLE I - IMPORTS

	Average daily transfer m.g.d.		
	1971	1981	2001
Liverpool C.B.C. transfer from Severn	44.2	44.2	44.2
" " " " Dee	36.4	55.9	64.0
" " " " Lancs.	3.2	2.7	1.4
Manchester C.B.C. " " Cumberland	85.9	85.9	85.9
Mid Cheshire W.B. " " Severn	0.9	0.9	0.9
" " " " " Dee	7.2	7.3	6.8
Oldham C.B.C. " " Yorkshire Ouse & Hull	1.6	1.6	1.6
Rochdale C.B.C. " " " " "	1.7	1.7	1.7
Wirral W.B. " " Dee	25.7	25.5	24.5
Totals - m.g.d.	206.8	225.7	231.0

TABLE III - EXPORTS

	1971	1981	2001
West Lancashire W.B. transfer to Lancashire	1.1	1.2	0.4

TABLE IV - EFFECTIVE DEFICIENCIES

	1971	1981	2001
Effective deficiencies by deduction of imports from deficiencies in Table I - to nearest 5 m.g.d.	35	95	265

APPENDIX II

LANCASHIRE RIVER AUTHORITY

PUBLIC WATER SUPPLY

TABLE I

Ref. No.	Undertaking	Average daily demands m.g.				Resources m.g.d.					Apparent Overall Deficiencies (-) or Surpluses (+) on Net Resources - m.g.d.					
		1965	1971	1981	2001	1965	Authorised	(3)Bulk Supplies +	(3)Bulk Supplies -	Net Authorised	1971 +	1971 -	1981 +	1981 -	2001 +	2001 -
	Adlington U.D.C. (1)	0.2	0.2	0.3	0.5	-	-	0.3	-	0.3	0.1	-	-	-	-	0.2
	Blackrod U.D.C.	0.1	0.2	0.3	0.6	0.3	0.3	-	0.1	0.2	-	-	-	0.1	-	0.4
	Calder W.B.	9.9	11.0	13.4	19.9	8.0	10.1	1.7	-	11.8	0.8	-	-	1.6	-	8.1
	Chorley R.D.C.	1.4	1.6	2.0	2.7	-	-	1.7	0.2	1.5	-	0.1	-	0.5	-	1.2
	Craven W.B. (4)	0.7	0.9	1.1	1.3	0.7	0.8	-	-	0.8	-	0.1	-	0.3	-	0.5
	Furness W.B.	8.2	10.0	12.5	15.0	10.8	10.8	-	-	10.8	0.8	-	-	1.7	-	4.2
	Fylde W.B.	31.3	38.0	48.0	68.0	34.3	37.1	0.2	0.3	37.0	-	1.0	-	11.0	-	31.0
	Horwich U.D.C. (1)	0.8	0.9	1.1	1.7	0.9	0.9	-	-	0.9	-	-	-	0.2	-	0.8
	Lakes & Lune W.B.	3.2	3.7	4.2	4.8	3.7	3.7	0.8	-	4.5	0.8	-	0.3	-	-	0.3
	Liverpool C.B.C. (1) (2) (5)	1.9	2.1	2.6	3.9	9.5	9.5	-	4.2	5.3	3.2	-	2.7	-	1.4	-
	Lune Valley W.B.	7.3	9.0	10.3	12.0	12.0	12.0	0.5	-	12.5	3.5	-	2.2	-	0.5	-
	Makerfield W.B. (6)	6.9	9.4	12.0	18.8	1.2	1.2	10.1	2.5	8.8	-	0.6	-	3.2	-	10.0
	Manchester C.B.C. (7)	-	-	-	-	-	-	-	14.9	14.9	-	14.9	-	14.9	-	14.9
	North Calder W.B.	3.4	4.1	5.1	7.0	4.1	4.7	-	-	4.7	0.6	-	-	0.4	-	2.3
	Preston & District W.B.	13.2	16.9	28.9	42.3	10.2	10.7	4.3	0.1	14.9	-	2.0	-	14.0	-	27.4
	South Cumberland W.B. (8)	0.6	4.7	5.0	5.4	0.9	0.9	-	-	0.9	-	3.8	-	4.1	-	4.5
	West Lancashire W.B. (6)	5.4	7.0	10.7	13.3	3.4	3.4	2.5	-	5.9	-	1.1	-	4.8	-	7.4
	Withnall U.D.C. (1)	0.2	0.2	0.3	0.5	-	-	0.2	-	0.2	-	-	-	0.1	-	0.3
	Totals m.g.d.	94.7	119.9	157.8	217.7	100.0	106.1	22.3	22.3	106.1	9.8	23.6	5.2	56.9	1.9	113.5

NOTES:
(1) No details submitted by the undertakings. Estimates prepared from existing data.
(2) Demands in Chorley M.C. area only included.
(3) Assuming existing obligations or transfers will continue.
(4) Craven W.B. appears also in the Yorkshire Ouse and Hull River Authority Table I.
(5) Liverpool C.B.C. appears also in the Dee and Clwyd and Mersey and Weaver River Authorities Tables I.
(6) Makerfield W.B. and West Lancashire W.B. appear also in the Mersey and Weaver River Authority Table I.
(7) Manchester C.B.C. appears also in the Mersey and Weaver River Authority and Cumberland River Authority Tables I.
(8) South Cumberland W.B. appears also in the Cumberland River Authority Table 1.

APPENDIX II

TABLE II - IMPORTS

	Average daily transfers m.g.d.		
	1971	1981	2001
Manchester C.B.C. transfer from Cumberland to bulk supply recipients	14.9	14.9	14.9
West Lancashire W.B. transfer from Mersey and Weaver	1.1	1.2	0.4
Totals m.g.d.	16.0	16.1	15.3

TABLE III - EXPORTS

	1971	1981	2001
Liverpool C.B.C. transfer to Mersey and Weaver	3.2	2.7	1.4

TABLE IV - EFFECTIVE DEFICIENCIES

	1971	1981	2001
Effective deficiencies by deduction of imports from deficiencies in Table I - to nearest 5 m.g.d.	10	40	100

CUMBERLAND RIVER AUTHORITY

PUBLIC WATER SUPPLY

TABLE I

Ref. No.	Undertaking	Average daily demand m.g.				Resources - m.g.d.					Apparent overall deficiencies (-) or supluses (+) on net resources - m.g.d.					
		1965	1971	1981	2001	1965	Autho-rised	Bulk supplies		Net Authorised	1971 +	1971 -	1981 +	1981 -	2001 +	2001 -
	Carlisle C.B.C.	4.7	5.3	6.3	9.4	6.9	6.9	-	0.1	6.8	1.5	-	0.5	-	-	2.6
	Eden W.B. (4)	2.7	3.0	3.5	4.5	1.7	2.6	1.2	-	3.8	0.8	-	0.3	-	-	0.7
	Keswick U.D.C.	0.4	0.4	0.4	0.5	0.4	0.6	-	-	0.6	0.2	-	0.2	-	0.1	-
	Manchester C.B.C. (5)	-	-	-	-	102.0	102.0	-	1.2	100.8	100.8	-	100.8	-	100.8	-
	S. Cumberland W.B.	8.8	20.5	42.7	57.0	9.7	15.7	0.4(3)	-	16.1	-	4.4	-	26.6	-	40.9
	W. Cumberland W.B.	5.1	15.0	22.2	29.0	14.6	16.6	0.1	-	16.7	1.7	-	-	5.5	-	12.3
	Totals	21.7	44.2	75.1	100.4	135.3	144.4	1.7	1.3	144.8	105.0	4.4	101.8	32.1	100.9	56.5

NOTES:
(1) Lakes and Lune W.B. within Cumberland R.A. area, resources and demands less than 0.1 m.g.d., not included.
(2) Assuming existing obligations or transfers will continue.
(3) Net gain of 0.4 m.g.d. from U.K.A.E.A.
(4) Eden W.B. appears also in the Northumbrian River Authority Table I.
(5) Manchester C.B.C. appears also in the Mersey and Weaver and Lancashire River Authority Tables I.
(6) South Cumberland W.B. appears also in the Lancashire River Authority Table I.

TABLE II - IMPORTS - NIL

TABLE III - EXPORTS

	1971	1981	2001
Manchester C.B.C. transfer to Lancashire	14.9	14.9	14.9
Manchester C.B.C. transfer to Mersey and Weaver	85.9	85.9	85.9
Totals - m.g.d.	100.8	100.8	100.8

TABLE IV - EFFECTIVE DEFICIENCIES

	1971	1981	2001
Effective deficiencies from Table I - to nearest 5 m.g.d.	5.0	30.0	55.0

WATER RESOURCES BOARD

INTERIM REPORT ON WATER RESOURCES IN THE NORTH

MAP OF STUDY AREA

STATUTORY WATER UNDERTAKINGS

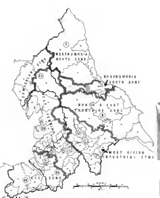
1. Adlington U.D.C.
2. Ashton-under-Lyne, Stalybridge and Dukinfield (District) Waterworks Joint Committee
3. Barnsley C.B.C.
4. Bingley U.D.C.
5. Blackrod U.D.C.
6. Bolton C.B.C.
7. Bradford C.B.C.
8. Calder Water Board
9. Calderdale Water Board
10. Carlisle C.B.C.
11. Cowling R.D.C. (Part)
12. Central Flintshire Water Board
13. Central Nottinghamshire Water Board (Part)
14. Chester R.D.C.
15. Chester Waterworks Co.
16. Chorley R.D.C.
17. Clare Water Board
18. Craven Water Board
19. Croft R.D.C.
20. Darlington C.B.C.
21. Darlington R.D.C.
22. Doncaster and District Joint Water Board (Part)
23. Durham County Water Board
24. East Shropshire Water Board (Part)
25. East Yorkshire (Wolds Area) Water Board
26. Eden Water Board
27. Eston U.D.C.
28. Flaxton R.D.C.
29. Furness Water Board
30. Fylde Water Board
31. Hartlepools Water Co.
32. Heywood and Middleton Water Board
33. Horwich U.D.C.
34. Huddersfield C.B.C.
35. Keswick U.D.C.
36. Kingston-upon-Hull C.B.C.
37. Lakes and Lune Water Board
38. Leeds C.B.C.
39. Leek R.D.C. (Part)
40. Liverpool C.B.C.
41. Lune Valley Water Board
42. Macclesfield District Water Board
43. Malton R.D.C. (Part)
44. Makerfield Water Board
45. Manchester C.B.C.
46. Merioneth Water Board (Part)
47. Mid-Calder Water Board
48. Mid-Cheshire Water Board
49. Millom R.D.C. (Parish of [illegible])
50. Newcastle and Gateshead Water Co.
51. Northallerton and the Dales Water Board
52. North Calder Water Board
53. North Derbyshire Water Board (Part)
54. Norton U.D.C.
55. Oldham C.B.C.
56. Pontefract, Goole and Selby Water Board (Part)
57. Preston and District Water Board
58. Pudsey M.C.
59. Rawmarsh U.D.C.
60. Rochdale C.B.C.
61. Rossendale Water Board
62. Rotherham C.B.C.
63. Runcorn District Water Board
64. Ryedale Joint Water Board
65. Saddleworth U.D.C.
66. St. Helens C.B.C.
67. Scarborough M.B.
68. Sheffield C.B.C. (Part)
69. South Cumberland Water Board
70. Spenborough M.B.
71. Staffordshire Potteries Water Board (Part)
72. Stockport and District Water Board
73. Stokesley R.D.C.
74. Sunderland and South Shields Water Co.
75. Tees Valley and Cleveland Water Board
76. Tynemouth C.B.C.
77. Wakefield and District Water Board
78. Warrington C.B.C.
79. West Cumberland Water Board
80. West Lancashire Water Board
81. West Shropshire Water Board (Part)
82. West Denbighshire and West Flintshire Water Board (Part)
83. Widnes M.C.
84. Wirral Water Board
85. Withnell U.D.C.
86. Wrexham R.D.C.
87. Wrexham and East Denbighshire Water Co.
88. York Waterworks Co.

RIVER AUTHORITIES

① NORTHUMBRIAN
② YORKSHIRE OUSE & HULL
㉔ DEE & CLWYD
㉕ MERSEY & WEAVER
㉖ LANCASHIRE
㉗ CUMBERLAND

BOUNDARIES

- Study Area
- Demand Zone
- River Authority
- Statutory Water Undertaking



NORTHUMBRIA NORTH ZONE

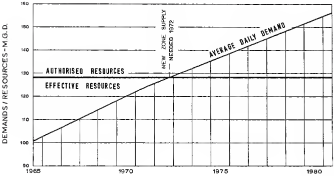


FIG. 1

NORTHUMBRIA SOUTH ZONE

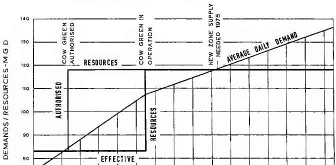


FIG. 2

NORTH AND EAST YORKSHIRE ZONE

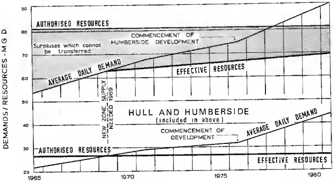


FIG. 3

WEST RIDING INDUSTRIAL ZONE

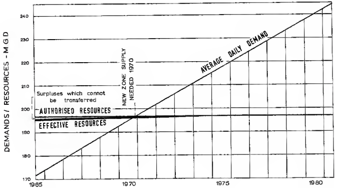


FIG. 4

DEE ZONE

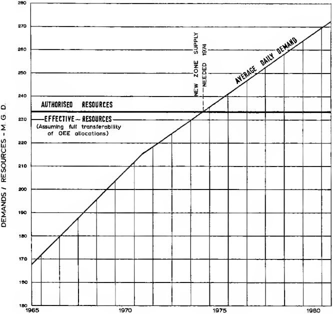


FIG. 5

WEST PENNINE ZONE

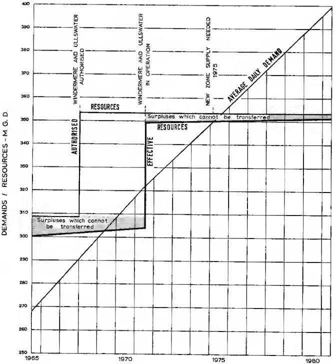


FIG. 6

CUMBERLAND ZONE

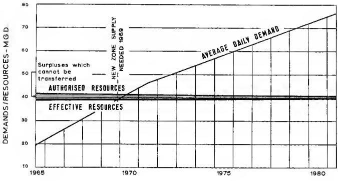


FIG. 7